Abstract for the DPS meeting in Padua, October 1999

A Three Dimensional Thermal Model of an Irregular Cometary Nucleus

A. Enzian, R. G. Gaskell, and P. R. Weissman
Jet Propulsion Laboratory, California Institute of Technology
Pasadena, CA, 91101

We have developed a new, 3-dimensional comet nucleus thermal model. Shape and topography of the hypothetical comet nucleus are generated with a ballistic accretion Monte Carlo model of planetesimal accretion. The accreted random shape can be stretched to match the axial ratio of a real cometary nucleus. The surface of the modeled comet nucleus can be convoluted with an albedo map to simulate both homogeneous and inhomogeneous water ice/dust compositions. The outgassing distribution on the surface of the comet nucleus is estimated via an energy balance equation that takes into account the principal thermal processes on the sunlit side of the active comet nucleus: absorption of solar flux, thermal reradiation, and surface sublimation of water ice. Thermal flux into the interior and activity on the dark side are not modeled yet, but will be included in the future. Shading and nucleus rotation are considered. A linear correlation between water outgassing and dust emission is assumed. The dust outflow in the coma is computed with a 1-dimensional parameterized model, which assumes that the grain motion is in the normal direction relative to the local surface. Synthetic images of the comet nucleus and the near-nucleus coma are computed. The brightness of the coma is scaled to the optical depth of a real comet.

Since ice sublimation scales exponentially with temperature, the surface regions that receive full sunlight are most efficient in producing outgassing and dust emission. These regions form active areas that give birth to dust jets features in the near-nucleus coma, while the surface areas close to the terminator appear essentially inactive. For this reason the outflow tends to be directed towards the sun. The rotating comet nucleus displays numerous active regions on the sunlit side, which have a complex apparent motion. The light curve of the near-nucleus coma has a relative amplitude that is roughly twice as large as the light curve of the ellipsoidal nucleus. This behavior is due to the exponential behavior of ice sublimation, which suggests that the larger the radius of curvature of the topography the more efficient the sublimation.